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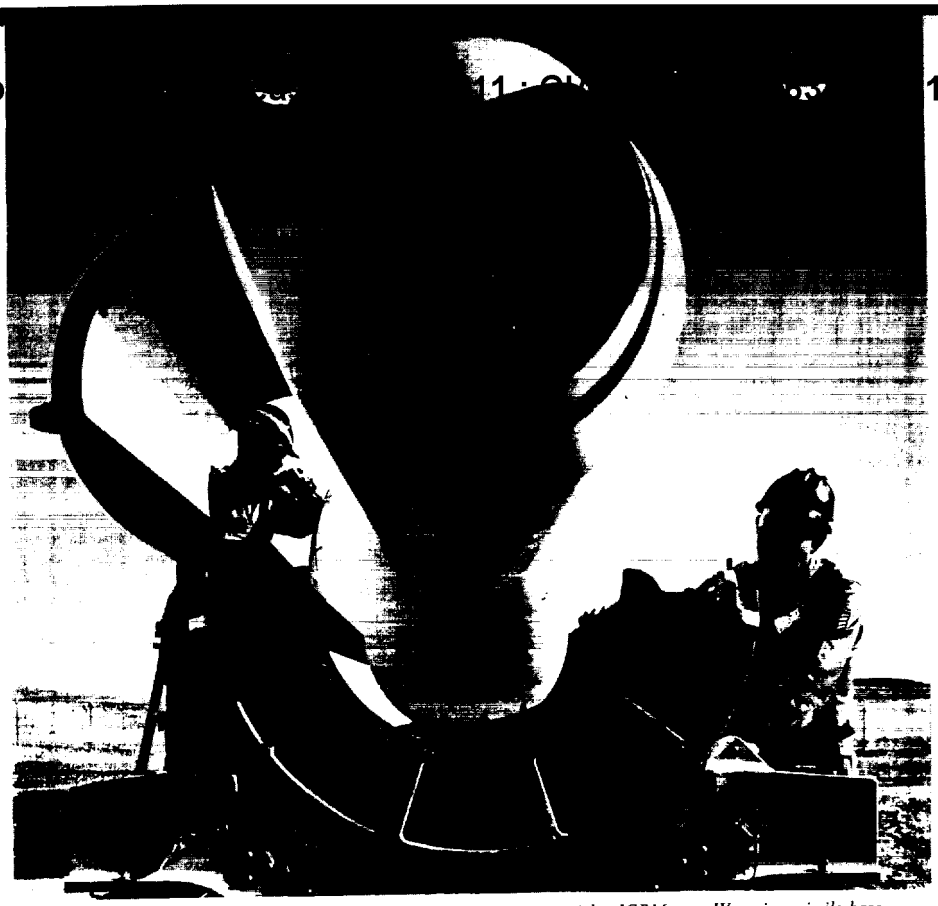

Air Force technicians ready a nuclear warhead for mating to an Atlas ICBM at a Wyoming missile base.

Outer Space: The Next Battlefield?

New developments in the space race include death rays and gigaton bombs. A *Post* editor considers their use in a fourth-dimensional war. • By STEWART ALSOP

The warhead of the Atlas intercontinental ballistic missile is about as big as a small Christmas tree. It could be carried in a large pickup truck, and a big man could put his arms most of the way around the warhead's stubby, cream-colored snout.

Looking at that cream-colored snout, which I saw at an Atlas base in Iowa, I found it somehow hard to believe that it could really destroy a great city halfway round the world and kill perhaps half a million people. It was hard to believe that it could do those things in less than thirty minutes after the base commander pushed the plastic-covered GO button back in the command post. But it could.

As Archibald MacLeish has written, "It is now possible, for the first time in human history, to know as a mind what you cannot comprehend as a man." That Atlas missile, or ICBM, with its cream-colored snout, is our first true space weapon. It is already obsolescent—follow-on missiles, like the Titan and the Minuteman, will do the job better. And the emptiness of space, which alone makes it possible to hurl that cream-colored snout halfway round the world, will no doubt in time be used for other, even more terrible, weapons of war. Yet phrases like "space warfare" are unreal to us—we neither "know as a mind" nor "comprehend as a man" what they really mean.

It is a cliché nowadays to say that the struggle for supremacy in space may determine the future of mankind. But like many clichés, this one happens to be true. This is why, after seeing that cream-colored snout, I decided to try to write about space warfare in terms that even a scientific illiterate like myself could understand.

The official U.S. policy, of course, is that space should be used only for "peaceful purposes." But no military man on either side of the world believes that space will be used for peaceful purposes alone. "The struggle in and for outer space," Gen. G. I. Pokrovsky of Russia announced two days before the launching of the first Sputnik in 1957, "will have tremendous significance in the armed conflict of the future." More recently, Gen. Bernard Schriever, chief of our military space program, said that in the future "the important battles may not be sea battles or air battles, but space battles."

We are already spending over $5,000,000,000 a year on the conquest of space, for military as well as peaceful purposes. That sum may double and even triple. The Soviets are making a similar investment in order to assure victory in the "struggle in and for outer space." What is the struggle all about? What form might those "space battles" take?

As of today, neither General Pokrovsky nor General Schriever nor anyone else can give

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precise or detailed answers to those questions. But on both sides the specialists in this strange new form of warfare are beginning to get a glimmer of what the answers might be. In order to get such a glimmer, it is first necessary to understand the peculiar nature of the space environment.

We live, as every knowledgeable sixteen-year-old boy knows nowadays, at the bottom of a great sea of air, or atmosphere. But there is no sharp break between air and space, as there is between ocean and air—it is as though the air-ocean dissolved into an ever-thinning mist.

One scientist gives this ungrammatical and unscientific definition of space: "Space is where there ain't nothin'." In a sense, space begins at about 55,000 feet, where most aircraft begin to "mush out" for lack of air to press against their wings—thus a reader who has flown at altitudes above 30,000 feet in a jet has been closer to the beginnings of space than to the earth. But true space can be said to begin 100 miles up, about the lowest altitude at which a satellite can orbit without being slowed down by the atmosphere and forced to reenter it. Up there the molecules of air are hardly within speaking distance of one another, and there is *almost* "nothin'."

It is curiously difficult to "comprehend as a man" the characteristics of nothingness, just as it would be difficult for even an intelligent fish to comprehend the characteristics of air. In trying to comprehend the nature of nothingness, one phrase constantly repeats itself—"there is no."

There is, first and foremost, no air in space. Thus a space vehicle does not "fly" in an earth-bound sense—it has no wings because there is no air for its wings to press against. "My pa was a flying man in his day," says one Air Force general, "and the old man just can't get it through his head how we can send a big thin-skinned balloon around the earth at 18,000 miles an hour." A space vehicle, once in orbit, can be any old size and shape.

No Sound, No Horizon, No Weight

There is no sound in space, only an unending silence, and there is no blast from an explosion in space—blast, like sound, needs air. There is no horizon in space, and no air to limit vision, or to cushion or attenuate the emission of light, or power, or neutrons. Finally, as everyone knows since the Glenn and Carpenter flights, there is no weight in space—not in our conventional sense. The characteristic of weightlessness derives from the fact that the velocity of a vehicle in orbit balances the gravity of the earth.

This characteristic is almost as difficult to "comprehend as a man" as the notion of nothingness. We instinctively tend to think of a space vehicle as though it were just another kind of airplane, higher up. The best way to understand the vital difference between the two is to imagine a rather homely little scene.

The chief actors in this little scene are a boy on a lawn and a bird in the air above him. The boy picks up a stone and throws it at a tin can. The boy's arm determines the speed and distance and direction of the stone, but once it has left his hand, he has no more control over it. The stone is a ballistic missile. But unlike the stone, an ICBM travels through the unresistant nothingness of space to its target. Thus it is the nothingness of space that makes it possible to hurl a nuclear warhead, like that cream-colored snout I saw in Iowa, to a target 6000 miles away. To throw its warhead halfway round the world, an ICBM requires a speed of upward of 16,000 miles an hour.

Now the boy picks up another stone and ties a string to it and whirls it about his head. He lengthens the string and whirls the stone faster, or he shortens the string and whirls it slower. To this extent the stone can change its position in relation to the boy's head—the stone can "maneuver." But its field of maneuver is strictly limited and, if the boy whirls too slowly, the stone falls to the ground.

Stepping on the Gas in Space

The bird, by pressing its wings against the air, can maneuver freely in any direction. In this analogy the bird is an aircraft and the whirling stone is a space vehicle. "Orbital velocity"—a bit more than 18,000 miles an hour—is the string, which balances the gravitational pull of the earth. Increase this speed, and the string is lengthened, and the orbital vehicle goes higher above the earth. Increase it to about 25,000 miles an hour, and the string, as it were, escapes from the boy's hand, and the stone-space-vehicle flies free of the earth's gravitational pull.

The analogy, like most analogies, is imperfect. But it suggests why, as Under Secretary of the Air Force Joseph Charyk has remarked, "Space is inherently hostile to maneuver."

To understand why space is hostile to maneuver, imagine two manned satellites, or orbital vehicles, piloted by a couple of astronauts we shall call John and Ivan. Both are in the same orbit. Ivan's satellite is whirling about the earth a hundred miles or so ahead of John's. John wants to catch up. So he steps on the gas—he uses some means of propulsion to increase his speed. But by increasing his speed, John forces his vehicle into a higher orbit—the string, in the boy-and-stone analogy, is lengthened, and John is frustrated.

The only way for John to catch up with Ivan is to "duck down and come up again"—decrease his speed, get into a lower orbit, and then step on the gas to catch up with Ivan in the old orbit. Obviously this is a neat trick if you can do it. It is all the neater because, although an orbital vehicle is getting a free ride as long as it remains in its own orbit, it takes a lot of power for a vehicle to *change* its orbit, or even to change direction in an existing orbit. Power means fuel, and fuel means that much more weight to hurl up into space. Thus in the nature of things John's fuel supply is strictly limited, and this will still be true even when means of propulsion other than chemical fuel are perfected—ion energy, perhaps, or nuclear energy.

This is why Dr. Harold Brown, the Pentagon's youthful chief scientist, confidently predicts that "there aren't going to be any dogfights in space." And there are other ways, which may not have occurred even to the most space-minded sixteen-year-old, in which the peculiar characteristics of space will affect the "aerospace mission," as all Air Force officers are now taught to refer to the Air Force's job.

The space part of the aerospace mission can be divided into four parts. Here are the ways in which the newly usable environment of space can be used for military purposes:

First, the long-range ballistic missiles, like that Atlas I saw in Iowa and its more efficient descendants.

Second information—space vehicles for reconnaissance, for "surveillance" (sending up one satellite to have a look at another), for early warning, navigation, communication, weather information, mapping and the like. In these categories we already know pretty well where we are and where we are going. So do the Russians.

Third, the Active Defense—using the space medium to destroy hostile space vehicles or ICBM's.

Fourth, the Active Offense—using space vehicles, other than the ground-based ICBM's, to destroy enemy cities or other targets.

In these last two categories neither we nor presumably the Russians really know where we are or where we are going, though the specialists have some interesting gleams in their eyes. Let us have a look at each of these ways in which space can be used for making war.

The essentials of the ICBM story are quickly told. By the end of this year we will have more than 200 operational ICBM's, most of them "soft" Atlas missiles, above ground and unprotected from surprise attack. By the end of 1964 we will have more than 1000 ICBM's, most of them "hard" Titans and solid-fueled Minutemen. Add several hundred Navy Polaris missiles and the still-strong bomber force of the Strategic Air Command and you have a powerful deterrent force indeed.

If the intelligence estimates are accurate, this means that it is now the Russians who must worry about a "missile gap." Current estimates put Soviet ICBM strength at well under 100 missiles, instead of the 500 or more predicted four years ago. The Soviet production rate is also believed to be markedly lower than ours.

This raises an interesting question. If the intelligence was so wrong four years ago, how can we be so confident that the current estimates are right? If we have a look at the second way in which space can be used for military purposes—information—we can guess at a possible answer to that question.

Veil of Secrecy Descends

In the first days of his Administration, President Kennedy announced that the famous U-2 spy plane would not overfly the Soviet Union. But he said nothing about space reconnaissance vehicles. These days nobody else is saying anything about reconnaissance satellites either.

A year or so ago the Samos and Discoverer satellite programs got a lot of publicity. Now there is the silence of the grave—or of space. An order has gone out from the White House forbidding all public discussion of reconnaissance satellites. The order is meticulously obeyed. Whenever, in the course of doing my reporting for this article, I brought the *verboten* subject up, an opaque glaze would come over the eyes of knowledgeable officials.

Therefore I asked nonofficial experts with no access to secrets: Can a reconnaissance satellite do the same job the U-2 did? Common sense alone would suggest that the answer is "no." The U-2 took its pictures flying at an altitude of less than fourteen miles, at a speed of less than 1000 miles an hour. Could a satellite, moving at 18,000

comprehend as a man."

miles an hour 100 miles or more above the earth possibly do the same job?

Marry a little knowledge of the characteristics of space to common sense, and you may conclude that the answer is not necessarily "no." For the great altitude of a satellite slows its speed *in relation to the earth.* And even more than speed and altitude the great obstacle in high-level photographic reconnaissance is the earth's obscuring sea of atmosphere. The U-2, at fourteen miles up, flew at the outer edges of this air ocean. Thanks to the nothingness of space, for all practical purposes there is no more obscuring atmosphere between a satellite and the earth than there was between the earth and a U-2.

Saint, Midas, Tiros and Anna

Even at satellite altitudes, modern photographic techniques make it possible to identify objects smaller than a jeep. For a time the satellite recovery program was well publicized. Put these facts together, and they may suggest one possible answer to the question: How can we be so confident of our estimates of Soviet ICBM strength?

This is also enough to suggest that, in the matter of using space for militarily useful information, we already know pretty well where we are and where we're going. For example, there is the Saint surveillance project (renamed Project 621A after religious groups protested). The Saint satellite is designed to be shot into the same orbit with another satellite and have a good look at it, with television, cameras, and special sensing devices. This is a neat trick, for reasons already explained. But the experts are confident that the trick can be done, if the satellite to be inspected is an unmanned vehicle in a fixed orbit.

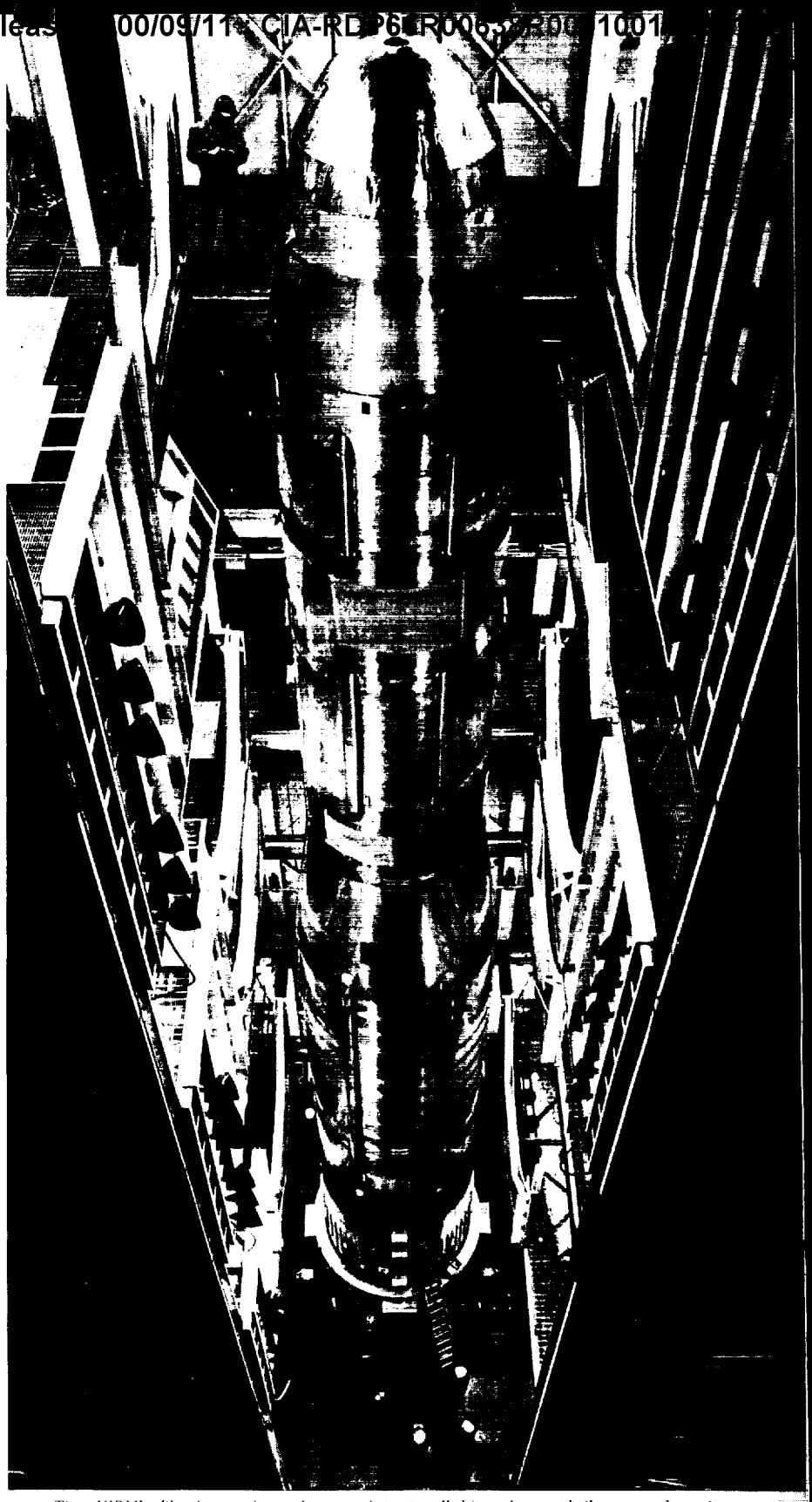
There are other projects for using satellites to gather militarily useful information—the Midas project, which calls for launching a dozen or more satellites with infrared sensing devices, to double the warning time in case of an enemy missile attack; Tiros, a weather satellite; Transit, a navigational aid; Anna, a mapping satellite. Although the Midas project has run into snags, the others are already operational, or will be rather soon.

These space vehicles are meant, in one way or another, to *see.* How about the Active Defense—using space to *kill* what otherwise might kill you?

Much depends on what you want to kill. An enemy ICBM? Very difficult. A hostile satellite in fixed orbit? Not so difficult. A man in a space vehicle? Rather easy. And there are all sorts of things you can use for the kill, ranging from steel pellets to the death ray of science fiction.

An ICBM is very difficult to kill for a simple reason. As one Pentagon scientist has remarked, "You've got to catch your rabbit before you can skin it." Because it is a one-shot proposition, an ICBM is very hard to catch. There is no way to predict its trajectory, and it can also be equipped with radar-fooling decoys—fake warheads of one sort or another. For these reasons among others, Secretary of Defense McNamara decided that the many billions of dollars which would be required to make an operational weapons system out of the Army's ground-based Nike Zeus anti-ICBM missile could better be spent for other purposes.

But orbital satellites are not one-shot propositions. They circle the earth in their preordained orbits and, as we have seen, it is not easy to shift them from one orbit to another. It is thus not



Titan ICBM's, like the one shown above, are being installed in underground silos across the nation.

"Because man is half monkey, it is almost sure he will use the fourth dimension

hard to predict where they will be and when, and they are therefore far more vulnerable to interception in space than ICBM's.

There are various ways to intercept them. A ground-based missile like the Nike Zeus is one way, and though here again it would be unwise to go into detail, the Nike Zeus is being readied for this role. There are, in fact, all sorts of ways to destroy a satellite, or render it useless.

For example, there is the Early Spring project, which got its name as a result of the protests against the name of the Saint project. Someone suggested that nobody was against motherhood or early spring—and the second designation was chosen. Early Spring is the pellet project.

Suppose you could shoot a large number of steel pellets, like the shot in a shotgun shell, into the path of a satellite rushing through space at 18,000 miles an hour. The collision of the satellite with even one pellet would tear it to bits, as a well-aimed shot kills a quail.

Tight Lips on "Neutron Flux"

A nuclear warhead is a more likely kill instrument than a pellet, because a nuclear warhead need not make direct contact with the object to be killed. As we have seen, because there is no air in space, there is no blast in space. But by way of compensation, the two other major effects of a nuclear explosion—heat and radiation—are greatly extended in range, because there is no air to cushion or attenuate them.

Thus the heat of a nuclear explosion might melt a satellite. Or the neutrons spat out by a nuclear explosion might interfere with the firing mechanism of a hostile nuclear weapon, or even "get into the nuke" of a nuclear bomb by starting a slow fission reaction.

Here we get into the phenomenon known as "neutron flux," and on this subject, too, the knowledgeable are tight-lipped. No one really knows for sure just how vulnerable a nuclear warhead might be to the explosion of another nuclear weapon in space. But there are two things which are unquestionably vulnerable to the radiation in space of a nuclear explosion.

One is photographic film, which can be clouded at great distances by nuclear radiation, thus rendering useless a reconnaissance satellite. The other is human tissue. An unprotected man in a satellite would be killed almost instantly by the radiation of a submegaton bomb exploded in space within fifteen miles of him. He would be killed, though less rapidly, by a very big bomb—say ten megatons—at a range of 500 miles.

Either pellets or bombs would be fired against a hostile satellite from a ground-based missile. But a satellite might also be used to kill another satellite. A surveillance satellite like Saint could kill as well as inspect—for example, a simple plastic explosive, like the bombs used by the anti-Gaullist *plastiqueurs* in Algeria, might be used for the job. But the job could hardly be done in such a way against a manned space vehicle capable of even limited maneuver.

If those "battles in space" between manned, maneuverable space vehicles, of which the Air Force men like to talk, ever take place, the weapon in these duels may be something called a Laser beam. The Laser beam (for Light Amplification by Stimulated Electromagnetic Radiation) is the space equivalent of the death ray.

Theoretically, light concentrated in a narrow "coherent" band would produce in the nothingness of space a short burst of energy, traveling at the speed of light—maybe enough energy to kill or render useless a missile or satellite. This notion is one of those difficult to "comprehend as a man." But it is taken seriously.

"We've looked into the phenomena associated with this kind of weapon," Gen. Curtis LeMay has said. "We have evidence from scientific papers that the Soviets also are interested." The Laser beam, LeMay points out, could be a decisive weapon, not only against space vehicles but "for the intervention of ICBM warheads and their decoys."

In fact, all the techniques mentioned so far, from the simple steel pellets to the Buck Rogers-like Laser beam could be used against ICBM's as well as against satellites. But because it is a one-shot proposition, the ICBM is very hard to catch at the receiving end.

Yet at the launching end, an ICBM is highly vulnerable. It is sending out a huge infrared signal, and even a gentle shove at this stage—perhaps with a Laser beam—will send it thousands of miles off course. This is why the idea of using satellites against missiles at the launching end is one of the gleams in the eyes of the space scientists.

The Bambi project is such a gleam. The idea is to orbit tens of thousands of small satellites, perhaps the size of a grapefruit, with a complex "brain" built into each. The brain would have to be pretty bright. It would have to detect the firing of any potential enemy missile, calculate its trajectory and decide whether to go after it, or to leave the job to some other Bambi missile in a better position to kill.

Gigaton Bomb: Possible Terror Weapon

This idea seems fantastic. But it, too, is taken seriously, and for a simple reason. If the Bambi project or something like it were ever perfected by any nation, that nation could deny space to any other nation.

This is enough to suggest the incredible complexities of the Active Defense in space. How about the Active Offense—the use of space vehicles to destroy enemy cities or other targets on the ground?

One "disturbing possibility" has been cited by Dr. Donald Brennan, president of Hudson Institute, Harmon-on-Hudson, New York, a nonprofit research organization looking into problems of national security. Doctor Brennan has written of the possibility of "placing in orbit a limited number of devices of very large yield (a few hundred megatons or more) which could be detonated at orbital altitudes (say 150 miles). . . . The thermal effects from such a high-yield device could set fire to a large fraction of a continent . . ."

Now hear Nikita Khrushchev, holding forth as usual in Moscow in December, 1961: "You do not have fifty- or one-hundred-megaton bombs. We have bombs more powerful than 100 megatons. We placed Gagarin and Titov in space, and we can replace them with other loads that can be directed to any place on earth."

Does Khrushchev have in mind Doctor Brennan's "disturbing possibility"? He has tested far-more-powerful bombs and missiles than we have tested. From his point of view there might be a certain logic in marrying his "gigaton" bombs ("gigaton" is a new word of art for bombs of enormously high yield) to the brute power of his huge missiles, to produce Doctor Brennan's terror weapon.

This might even explain in part the initial overestimation by our intelligence of Soviet missile production—Khrushchev might have opted instead for a "limited number" of terror weapons. Fortunately, most experts doubt that this is so.

As we have seen, a satellite is far more vulnerable than an ICBM. And as Doctor Brennan has pointed out, although a gigaton bomb might fry all New England on a clear day, on a cloudy day the thing might not work at all. "Areas covered by cloud at the time of detonation," Doctor Brennan writes, "probably would not be ignited."

On our side of the world most of the space-warfare specialists believe that a space vehicle capable of decisive offensive action will probably be manned and will probably *combine* the characteristics of an aircraft and an orbital vehicle.

It will be manned because, as one Air Force general puts it, "Man is still better than any black box, because he is more reliable and can exercise judgment—and being mass produced, he's a damn sight cheaper." And it will have the characteristics of a plane as well as a space vehicle because only thus can the inherent hostility of space to maneuver, and the dreadful vulnerability of both man and spacecraft, be overcome.

The American taxpayer is already contributing millions of dollars to the development of this kind of vehicle. There is Dyna-Soar (X-20), which will be a manned glider which can be shoved into orbit, and which will then be able to glide back to earth through the atmosphere to a dead-stick landing. Dyna-Soar may have its first test flight as early as 1965—already test pilots for aerospace vehicles like Dyna-Soar are in training at Edwards Air Force Base.

Much farther down the road—if it is down the road at all—is the aerospace plane. The aerospace plane, on its journey toward space through the atmosphere, would manufacture its own fuel from the air's oxygen. This fuel would then drive the plane into orbit and, when necessary, back down into the atmosphere for more fuel, like a cow returning to pasture. A vehicle capable of doing these things, and capable also of carrying weapons or acting as an invulnerable command post, would be a useful thing to have indeed. The trouble is that nobody really knows how the thing is to be done.

Our Moon as a Missile Base

Even Dyna-Soar will be a strictly experimental, nonmilitary vehicle, like the X-15 plane. "No one in his senses would propose building a complete space-weapons system today," says General Schriever. "The state of the art is just not that advanced—we're about where we were in aviation in 1910. But we do know, though we can't prove it, that space power will be as important as air power. And we also know, though we can't prove that either, that man will be as important in space as in the air."

The scientists are not so sure of these things as General Schriever is. In fact, there is a clear division of opinion between the scientists and the Air Force men. One disagreement concerns the establishment of a missile base on the moon. Given such a base, as one official report puts it,

to assert his power."

"any enemy . . . would have to launch an overwhelming attack toward the moon from its own land bases before attacking the U.S.A. or face certain destruction from moon bases within forty-eight hours." Most of the scientists consider this sort of thing mere moon madness. They contend that the deterrent role can be performed far more effectively from the earth's surface than from the moon.

Some of the more enthusiastic Air Force men—not Schriever—talk as though armadas of manned spacecraft would be flitting about through space tomorrow or the day after. The reason for this enthusiasm is obvious.

Whatever the outcome of the RS-70 controversy, the manned, air-breathing bomber is already on the way out, to be replaced in time by the ICBM's. The men of the Strategic Air Command especially dislike the notion of getting out of the wild blue yonder and into the ICBM command posts 150 feet underground. They would much rather get into the wild black yonder of space.

War in Space, Peace on Earth?

The scientists, vividly aware of the inherent hostility of space to maneuver and man's terrible vulnerability in space, are skeptical. Some, like Doctor Brown, even doubt that there is any useful military role for man in space at all. Most are convinced that for the foreseeable future the main deterrent role will be played by ICBM's, not space vehicles, simply because the ICBM can do its grisly task more neatly and more cheaply than any satellite.

To an outsider like this reporter, the scientists seem to have the better of the argument. Yet here one caveat must be entered. The scientists have consistently underestimated their own ability to meet the technical challenges of the new weapons. To cite two examples, Dr. Albert Einstein, in his famous letter to President Roosevelt, warned that an atomic bomb, if it could be made at all, could in all probability never be carried in a plane. And a big majority of President Truman's scientific advisers voted against proceeding with the H-bomb project, on the grounds that such a bomb was not technically feasible.

Certainly those "battles in space" between manned spacecraft are not going to take place tomorrow or the next day. What seems more possible—although this, too, is hard to "comprehend as a man"—is a sort of limited warfare in space, with both sides trying to knock out the other side's "eyes in the sky" and other space devices. This kind of warfare might even go on while the earth continued to spin on its axis beneath its life-giving sea of atmosphere, unaffected by the doings in space. In any case, the race for supremacy in space is not squarely joined.

Man, it has been said, is half god and half monkey. Because man is half god, his conquest of space, which has now begun, will one day surely be completed. Because man is half monkey, it is almost as sure that man will use the fourth dimension of space as he has used the earth, the sea, the air—to assert his power, to make his will prevail, perhaps to make war on other men. Because this is so, bar a firm and unlikely agreement with the other side to keep the heavens uncontaminated by the weapons of war, we cannot afford to fall behind in the race for space. THE END

General Bernard Schriever, tough boss of the Air Force Systems Command, ponders the U.S. military mission.